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ABSTRACT

A study examined primary children's learning in science in the areas of health and the environment through the use of drama activities. Parallel classes of children followed a similar half-term program of classroom science activities with their class teachers. The research took place in an urban school of approximately 300 pupils of mixed ability and background. Schemes of work for "minibeasts" in Year 3 and "our bodies" in Year 5 were developed to enhance health and environmental understanding through drama in one of the parallel classes in each year group. The children's attitudes and understanding were assessed before, during, and after the teaching program and the responses of the parallel groups were compared. Comparison of pre- and post-intervention assessments of the test group pupils confirmed they: (1) showed increased understanding of scientific concepts about the body to inform their views on health; (2) improved in levels detail, and scientific accuracy in their drawings about what is in the body; and (3) showed positive attitudes toward health throughout, but had a raised priority for health at the end of the teaching program. (Contains 14 references.) (RS)

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Drama and Primary Science.

by Michael Littledyke

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Drama and primary science

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Research findings are presented concerning the use of drama to support children's learning in primary science. The first section provides a rationale for the research as a summary of key points drawn from previous publications, which analyse modern and postmodern models of science and consider the need for the personalisation and politicisation of science education, particularly to develop understanding of important environmental and health issues (Littledyke, 1996, 1997, 2000b; Littledyke and Huxford, 1998; Littledyke, Ross and Lakin, 2000). The second section presents a summary of case studies of the use of drama in teaching science in the context of health and environmental education (Littledyke, 1994, 1998, 2000a; Littledyke, Robertson and Oldroyd, 1997). For a full analysis of the issues and detailed research findings see the original publications.

RATIONALE FOR THE PERSONALISATION AND POLITICISATION OF SCIENCE: SUMMARISED KEY POINTS

Models of science

Science has had great impact since the Enlightenment, influencing:

- understanding/concepts about the world: which have changed with new findings associated with new technologies and new perspectives
- technology: which has had beneficial effects, such as medical advances; and destructive influences, such as weapons of war, torture and environmental damage
- philosophy: as views about the nature of reality
- attitudes/beliefs: with moral implications concerning the application of scientific ideas through technology and the resulting consumer and political choices
- education

Models of science influence all of the above

Early models of science: modern science

17th century post-enlightenment scientific views have had great influence on society. These views were rooted in:

- Objectivity: the claim that science provides an emotionally distanced and accurate view of reality
- Dualism: the separation of mind and matter, reason and emotion, which is needed for objectivity
- Rationality: the assumption that the world can only be known through reason and this will lead to knowing it fully
- Neutral, value free stance: needed to achieve objective truth
- Reductionism: the proposition that science can know the whole by reducing it to its parts

- Mechanical view of the universe: in which reductionism describes the parts
- Positive realism: as a view of the world in which science is an approach to absolute truth which describes the real world independently of humans

Impact of modern science

- Objective, value free view of the world: may remove empathy, care, concern, responsibility, aesthetics, sense of awe and wonder
- Rationality dominates and feelings and ethical concerns are subordinated
- Reductionism loses sense of the whole
- A mechanical world-view influences technology, resulting in 'mechanomorphism', in which treating nature is treated as a machine
- Positivism and truth claims give undue power and status to scientific ideas
- Abstract science can be seen as boring, uninteresting and irrelevant to many people, which affects student choice

Changing models of science: postmodern science

All the previously listed features of modern science have been refuted by:

- **Postmodern philosophy**
  This challenges the meta-narratives of modernism through deconstruction of the cultural influences of ideas, which are held to be constrained by language, e.g. Rorty: '... for those who espouse a post-modern perspective, reality is nothing but a temporary text constructed out of other texts' (1982, p. 15).
- **Epistemology:**
  The history of scientific ideas shows that knowledge is tentative and changing: Any physical theory is always provisional, in the sense that it is only a hypothesis: you can never prove it ... (however), you can disprove a theory by finding even a single observation that disagreed with the predictions of the theory. (Hawking, 1988, p. 10)
  Also, scientific knowledge takes place in a social context which influences the nature of that knowledge (Kuhn, 1970; Medawar, 1979).
- **Fields of science:**
  Developments in science have refuted the assumptions of the modern model of science:
  - Quantum mechanics: shows that matter is inherently unpredictable in a finite sense and cannot be understood independently of an observer; this also shows deep relations in physical world
  - Complexity (includes 'chaos' theory): demonstrates the finite unpredictability of dynamic systems, with emergent order as a property of such systems
  - Ecology: studies inter-relationships between organisms
  - Genetics/evolution: shows deep relationships within living things
  - Neurophysiology: demonstrates perception/thought as a construction
  - Learning theory: constructivism as a theory of learning overturns positivism

Features of postmodern science education

Postmodern science education includes a revisionary approach to science, challenging the overturned assumptions of modern science and emphasising the personalisation

and politicisation of science. This includes effective and affective dimensions of learning.

Effective features of learning: purposes:

- to educate pupils into the methods and ideas of science so that they can use science to interpret and understand the world;
- to assist pupils in creating meaningful personal frameworks for understanding science;
- to critically analyse ideas and the application of ideas for scientific validity;
- to critically evaluate the social and environmental implications of the application of scientific ideas.

Affective learning: purposes

- to foster a sense of interest, enjoyment and excitement in learning in science;
- to include a sense of beauty, respect, reverence and awe in approaches to the environment and understanding our place in the universe.

DRAMA AS A TEACHING AND LEARNING STRATEGY TO SUPPORT MEANINGFUL SCIENCE

Drama provides a valuable teaching and learning strategy for promoting the personalisation and politicisation of science, which is a central feature of postmodern science.

Sometimes use of movement or modelling of scientific ideas using pupils themselves is classed as drama. For example, particle motion in solids, liquids or gases may be represented by pupils standing close together as a solid, moving further apart as a liquid or moving far away from each other as a gas.

However, educational drama typically involves real-life simulations. This has the value that it:

- uses whole person, including effective and affective modes i.e. it engages emotions as well as intellect;
- can be used to explore the impact and implications of scientific ideas and technology;
- develops understanding of the ideas and the issues/problems/choices through consequences of action;
- considers care, concern, empathy and responsibility, to inform choices;
- develops moral understanding through moral responses;
- provides vicarious experience, which can be compared to real life situations;
- supports the personalisation and politicisation of science.

Key features of educational drama

The following features of educational drama are particularly important to support pupils' understanding:

- Reflection: through slowing down or stopping action in the drama enables pupils to consider the significance of events in the drama.
- Discussion: helps reflection, through exposing and sharing of viewpoints.

- Uses characters, narrative, context, communication as in real life, which is easy for pupils to identify with.
- Dramatic tension provides focus for impact and consequences of action.
- Pupils can explore different views or experiences safely.

Case study
Use of drama in science and health and environmental education

Context and research design
The research took place in an urban school of approximately 300 pupils of mixed ability and background. Throughout the school two parallel classes in each year group follow identical schemes of work. Schemes of work for 'minibeasts' in Y3 and 'our bodies' in Y5 were developed to enhance health and environmental understanding through drama in one of the parallel classes in each year group.

All pupils in each Y3 and Y5 class were interviewed to assess initial understanding of the ideas and views on health or environmental matters. The findings were used to inform teaching, in that any misconceptions were challenged during the teaching and the main concerns were taken into account planning. Whilst one class in each year followed normal schemes of work the other class had drama extension activities, in which the content was negotiated with pupils All pupils were reassessed at the end to compare learning of science concepts, understanding of health or environmental issues and associated views. Comparisons in views and understanding at the beginning and end of the project were made in the classes which experienced the drama, as well as comparisons between the classes which had no drama and those which had.

It is acknowledged that in small-scale research of this nature it is notoriously difficult to control variables for cross group comparison. This means that any findings must be treated tentatively and that wider generalisations are problematic.

HEALTH AND OUR BODIES (y5)

Classroom based activities to develop scientific understanding (Sc2) and science investigation processes (Sc1)

The following table summarises the main phases in the teaching as experienced by both year 5 classes (for full details and examples of assessments see Littledyke et al., 1997):

stage / concepts / attitudes / key questions	**activities (supported by an extensive selection of supporting reference books)**
ORIENTATION	• pictures / books of human organ systems introduced in the class to arouse interest
ELICITATION what ideas / attitudes are held about keeping healthy? (used formatively to inform the subsequent teaching programme)	• small group (4) interviews to establish views / attitudes which are summarised by tables and concept maps of common views • important body organs and functions drawn on body outlines • written questions and drawings about what we need to do to keep healthy / unhealthy

LIFE PROCESSES CONCEPT what do living things need to stay alive?	• what is needed for life? what do we have in common with other living things? • what do we need to stay healthy?
ORGAN SYSTEMS how does our body work? what do we need to be healthy?	• elicit ideas about each system using key questions and annotated drawings in body outlines before each is studied • use of model body torso as a teaching tool to introduce the organs • use of paper cut out organs to identify the parts and their functions
NUTRITION why do we need food? (energy, growth repair) how do we make it available to the body (cells) (digestion, transport, role of oxygen, waste removal) what kinds of food do we need? (carbohydrates, protein, fats, vitamins, minerals, fibre + liquid)	• introduce the digestive system and the functions of the various parts • stick cut out organs onto a body outline and say what each part does • identify food groups which are rich in carbohydrates, proteins , fats, vitamins, minerals and fibre • design a healthy menu for a day • identify problems of imbalance - fat, sugar, salt, lack of fibre, obesity, anorexia • what foods keep us healthy/unhealthy and how do they affect the body?
BREATHING AND CIRCULATION why do we need air? what is blood for?	• introduce the main features of the breathing and circulatory system • investigation of pulse and breathing rate after exercise • chest expansion and lung capacity • the heart as a pump • looking after your heart and lungs - exercise and diet (effect of excess fat) • problems of smoking and the effects on health
BONES AND MUSCLE how do we move / keep our shape	• introduce the main features of the skeletal and musculature system • examine movement and body positions - show how the muscles and bones work together - make stick pictures of movement • make art straw model skeleton / cardboard model joints to show movement • compare animal skeletons for adaptation • the importance of exercise and diet in health
SUMMATIVE ASSESSMENT	• revisit the elicitation activities to assess the learning that had taken place

Drama based activities to make the children's concepts and attitudes related to health and the body explicit

The drama was structured as a TV show (video-recorded) with the pupils as participants, ostensibly to teach other children about health. The educational purpose was to provide a medium for the pupils to help clarify and share their ideas so that the concepts developed in the class based activities could be placed in an interesting and meaningful context.

stages of the drama	activities
• brainstorming and selection of ideas	• discussion about interesting drama ideas for presenting a TV programme about health • children select the ideas for sections of 'The Body Show' and choose their roles
• 'The Body Show': introduction	• presenters introduce the show which is intended to teach the audience (children of similar age) how to keep healthy and what not to do
• interviews to show what people may do which is healthy or unhealthy	• people leaving a supermarket are interviewed to find out what they have bought (showing healthy/unhealthy eating patterns) • people are interviewed; in a street, park, outside a leisure centre to find out about exercise patterns
• studio guests, the *Crock* family are interviewed by the main presenters (and demonstrate very unhealthy patterns)	• *Glut* overeats and suffers from obesity • *Annie Rexia* diets excessively • *Grease* eats too many fatty foods • *Sweet-tooth* eats too many sugary foods • *Slob* takes no exercise at all • *Smog* smokes excessively
• a new presenter enters and introduces a new part to the show "This is your body' (like 'This is your life') The Crocks are shown what is happening to their bodies as a result of their particular life style	• each *Crock* family member is taken on a conducted tour of their body by the *Body Explorers* who are made microscopically small by a 'micro time travelling machine', enter the body and describe the conditions inside • after this they are transported into the future and describe what it is like after many years have passed • they describe excess fat in *Glut* who has a heart attack from high blood pressure. *Slob* is very unfit, has a weak heart and suffers a similar fate. *Annie Rexia* is too thin and becomes very ill and weak. • the *Sugar Finders* describe *Sweet-tooth's* mouth with decaying teeth which eventually fall out • the *Fat Detectives* show that *Grease* has occluded arteries and eventually has a heart attack • the *Lung Men* describe *Smog's* lungs which eventually develop a cancer tumour
• audience 'phone in'	• to give advice to the *Crocks* about how they may become more healthy
• problems of temptation (to illustrate the problems of peer pressure)	• scenes to show how it is not always easy to make healthy choices (the action is 'frozen' at a crucial point and spoken voices give the thoughts and dilemmas of the person being tempted) • a group of secondary students are smoking and offer one to a friend who isn't • another group offers drugs to a friend • a group of children in a shop choose very unhealthy foods - what does their friend choose?

• audience phone in to a panel of experts	• a doctor, dentist/hygienist and psychiatrist answer questions about difficulties in making choices (groups of children discuss the possible answers before the character in role speaks)
• the *Crocks* are re-interviewed	• they describe how they have taken the previous advice to improve their health and how their bodies have improved
• finale	• the presenter summarises what makes healthy living • the show finishes with a health rap (words in appendix 3.5)
• editing and completion	• the video material is edited and the completed 'Body Show' is made

Assessment of learning
Assessments of views and understanding of concepts were carried out at the beginning and end of the project, so that pupils' learning could be identified and cross-group comparisons could be made to see if there were differences, which may be due to the drama input.

Informal assessment showed high motivation in drama group. All pupils enjoyed their involvement in the drama activities and were motivated to find out about the scientific ideas so that their input into the drama was credible.

Formal assessment
't' test comparisons of NC scores (three-way moderated teacher assessment) were calculated for:
a) between classes for each year group
b) pre- and post-intervention
(e.g. 2a scored 2.67, 2b scored 2.33, 2c scored 2.0)
Initially parallel Y3 and Y5 classes showed equivalent ability, so any significant differences may be taken to be due to differences in their experiences.

Summative assessments from the 'health project'
A summary of the assessment findings is presented below as values of 't', degrees of freedom and significance levels (significant - $p<0.05$, very significant - $p<0.01$, highly significant - $p<0.001$).

Concern and reasoning about health issues
This was assessed through interviews and concept maps of ideas:
- the test group (drama) showed improved concern and reasoning compared to control (no drama):

Test group (drama) v control (no drama) summative assessment
$t = 5.18$ $df = 31.0$ $p<0.001$
Test group elicitation v summative assessment
$t = 5.01$ $df = 36.13$ $p<0.001$

Understanding of the body and health
This was assessed through 'what's inside the body, and what do we need to do to keep it healthy' annotated drawings:

- the test group showed more accuracy, detail and scientific understanding through their writing and drawing compared to control:

Test group (drama) v control (no drama) summative assessment
$t = 8.60$ $df = 30.0$ $p<0.001$
Test group elicitation v summative assessment
$t = 6.22$ $df = 30.0$ $p<0.001$

Attitudes to health
This was assessed through scaled questionnaire:
- Questions: 'It is important to keep healthy'; 'I try to keep healthy'; and 'I may give up or cut down on some things to keep healthy' – pupils generally agreed with no significant difference for test/control comparisons
- Question: 'There are more important things than keeping healthy' – the test group responded more positively than the control, though the test group's response to this at the beginning and end was just outside the significance level.

Test group (drama) v control (no drama) summative assessment
$t = 3.14$ $df = 26.0$ $p=0.004$
Test group elicitation v summative assessment
$t = 1.94$ $df = 29.14$ $p=0.062$ (approaching significance)

Health and lifestyle choices
Summative assessment activity: Pupils were asked to identify from a list foods contain fat, sugar, carbohydrate, protein, minerals and vitamins, and fibre. They were also asked what are the results of:
- excess food;
- insufficient food;
- excess sugar;
- excess fat;
- insufficient fibre;
- lack of minerals and vitamins;
- lack of exercise;
- the likely effects of drugs; tobacco, alcohol, glue, hard drugs.

No significant differences were found for test/control comparisons for this assessment.

Summary and conclusions
Comparison of pre and post-intervention assessments of test group pupils confirmed they:
- showed increased understanding of scientific concepts about the body to inform their views on health;
- improved in details, and scientific accuracy in their drawings about 'what's inside the body?';
- showed positive attitudes to health throughout, but had a raised priority at the end of the teaching programme.

Comparisons of summative assessment mean scores between the test and control groups showed that:

- in summative interviews the children from the test group showed better understanding than the control group of scientific concepts about the body to inform their views on health;
- the test group showed more accuracy, more inclusions, more details, and better scientific understanding in their drawings about 'what's inside the body?';
- both groups of children showed generally positive attitudes to health throughout, but children in the test group showed a raised priority for health.

ENVIRONMENTAL INVESTIGATION (Y3)

Classroom/school environmental area based activities

The activities were selected to develop understanding about aspects of ecology, whilst attitudes fostering care of living things and the environment were emphasised throughout the teaching programme. A summary of the activities is shown below (for full details and examples of assessments see Littledyke et al., 1997):

stage / concepts / attitudes / key questions	**activities (supported by an extensive selection of supporting reference books and the school environmental area, including pond and shrubbery)**
ORIENTATION	• pictures / books of animals and plants • exploratory visits to the environmental area
ELICITATION what ideas / attitudes are held about animals, plants and the environment	• small group (4) interviews to establish views / attitudes by making concept / attitude maps of common views
LIVING THING CONCEPT	• make drawings of living and none living things • group objects into living / not living and other categories (include human) • list into order of importance and say why
ANIMAL / PLANT CONCEPTS	• order a collection into animals and plants (include human) • what do they need to live? • how do we care for animals / plants and how may we use them / harm them?

ECOSYSTEM Hedgerow - animals and plants living together naturally	• what kinds of places / conditions? e.g. air, on plants (leaves/stems) , on surface, in soil • kinds of animals / plants and where found • attitudes toward the animals and plants • using and making simple keys • make a micro - hike (follow a trail with a hand lens) • how are they able to live (adapted)? (select different kinds e.g. snails, woodlice, earthworms - grass, shrub flower) • how do they reproduce? choose an animal • and a flowering plant identify parts and their functions germinate seeds - investigate conditions grow runner beans under different conditions - record stages in development • who eats what? • make a nature trail (display) to show features
COMPARISON Pond	• similar approach to above • compare adaptations to the different conditions • display to contrast the two ecosystems • creative writing (life in the pond /hedgerow), poetry, art
HUMAN CONNECTIONS animals / plants which we use	• plants for food - vegetables and fruits - parts of the plant • animals for food, leisure (e.g. fishing, hunting) • natural ecosystems - loss of habitats through building, endangered species
SUMMATIVE ASSESSMENT	• revisit the elicitation activities to assess the learning that had taken place

Drama structure – see fig1

Summary of pupil assessments

Elicitation activities were carried out before the teaching activities to find out about the children's understanding and views about animals and the environment. These activities were repeated after the teaching programme to assess what learning had occurred.

There were no significant differences in understanding of scientific concepts and environmental concern between the test and control group.
However, above average children (NC level 3) from the test group showed significantly better reasoning of environmental matters compared to equivalent ability pupils from the control group.

Evaluation

- There was evidence that the teaching programmes in the test groups had been successful in enhancing affective and effective responses.
- Pupils showed particularly high motivation and interest, showed enhanced scientific learning (y5) and increased ability to reason and justify their points of view (y5 and above average Y3 pupils)

- The drama activities provided a forum for the children to present their points of view.
- This provided a clear connection between the science concepts learnt from classroom activities and issues which had direct importance to their own lives.

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